



FEMA

TechNote

U.S. Department of Homeland Security



System Assessment and Validation for Emergency Responders

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) Program to assist emergency responders making procurement decisions. The SAVER Program conducts unbiased operational tests on commercial equipment and systems and provides those results along with other relevant equipment information to the emergency response community in an operationally useful form. SAVER provides information on equipment that falls within the categories listed in the DHS Authorized Equipment List (AEL).

Information provided by the SAVER Program will be shared nationally with the responder community providing life- and cost-saving assets to federal, state, and local responders.

The SAVER Program is supported by a network of technical agents who perform assessment and validation activities. Further, SAVER focuses primarily on two main questions for the emergency responder community: "What equipment is available?" and "How does it perform?"

For more information on this and other technologies, please see the SAVER website or contact the SAVER Program Support Office.

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License Plate Recognition



With the ever-advancing capabilities of modern computing platforms, new tools are becoming available to law enforcement professionals. Specifically, Automated Video Surveillance (AVS) technologies are now capable of extracting text from images using Optical Character Recognition (OCR) technology. The combination of OCR with advanced heuristics (algorithms) within AVS technology has evolved into License Plate Recognition (LPR) technology, which can automatically identify license plates. LPR technology automates what is normally a tedious and labor-intensive process to provide information to law enforcement professionals. For example, LPR could provide a list of all vehicles in a parking lot without requiring the positioning of guards at all entry and exit points.

Multiple Names in Use

Globally, LPR systems have been independently developed in several locations. Therefore, LPR technology is known by many different names:

- Automatic License Plate Recognition (ALPR)
- Automatic Number Plate Recognition (ANPR)
- Automatic Vehicle Identification (AVI)
- Car Plate Reader/Recognition (CPR)
- Optical Character Recognition (OCR).

While this list is not complete, it illustrates that there can be some confusion when discussing LPR technology. Regardless of the name used, the concept of collecting license plate information from different vehicles with an automated system is the same.

How License Plate Recognition Works



All LPR systems consist of three major components: **Imaging Subsystem**, **Recognition Software**, and **User Output**. The imaging subsystem is responsible for providing high quality image

data to the recognition software that provides the license plate data to the user.

The old proverb "a chain is no stronger than its weakest link" holds true with an LPR system. In order for an LPR system to work well, all three components must be robust and work together.



IMAGING – The imaging subsystem is the first link in the LPR chain. The imaging subsystem consists of cameras, lenses, illumination, and image capture components. The task of the imaging subsystem is to provide a high quality image. High

quality, in this sense, means an image having the following characteristics:



Resolution. The resolution of the image must be high enough to read a license plate clearly. This is much like an eye chart seen at an optometrist’s office. Text will eventually become too small to read.

Likewise, if there is not enough resolution in the image, the recognition software will not be able to detect the individual characters making up the license plate.



Sharpness. The image must be sharp enough (in focus) to enable the software to detect the edges of the individual characters making up the license plate number. Edges are important in determining the boundaries and shapes of the individual characters.



Contrast/Exposure. The image must have enough contrast between the text and the license plate’s background for the recognition software to read the characters on the plate. If the contrast is too low, the characters cannot be extracted from the license plate.

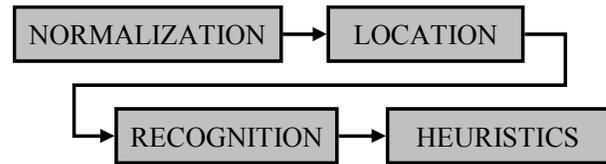
It is the equivalent of trying to read something lightly written with a pencil versus a pen with black ink—the task is difficult because of the low contrast.

The greatest challenge to the imaging subsystem is working in all weather conditions, both day and night. Many different approaches have been developed to meet different environmental needs. Some LPR systems use infrared (IR) lighting and special IR cameras to “see in the dark.” Other systems use a more conventional flashbulb with a high performance camera to capture the image. A third approach is the use of a very high dynamic range camera to obtain a high quality image for the recognition software. It is important to identify the needs of the user to properly select the LPR system that meets their application.



RECOGNITION – The recognition software is the second link in the LPR chain.

This software normally runs on a stand-alone computer; however, some systems run the software on a Digital Signal Processor (DSP) located within the camera. Regardless of where the software is operating, it consists of many algorithms that process the image and text from the license plate. The software usually operates in four phases: normalizing the image, locating the license plate, OCR, and high-level heuristics.



Normalization. Normalization is the process that ensures the raw data provided by the image subsystem are of sufficient quality for the rest of the algorithms to work. Quite often, the normalization process will enhance the contrast, sharpen the image, and convert the image to black and white.

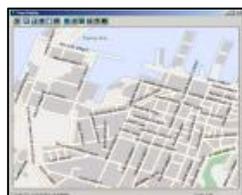
Location. The process of pinpointing the license plate is the next phase of the process. This step is completed for two primary reasons. First, OCR is a difficult task for a computer to perform, so only having to search a portion of the image for characters allows for a more efficient system. Second, in order to avoid obtaining nearby characters and thus returning false license plates, characters should only be derived from the license plates themselves. The location of a license plate varies depending on the type of vehicle. If the location step is omitted, characters could be obtained from other locations on the vehicle, such as container markings, in addition to the license plate.



Recognition. OCR is the process that extracts the raw characters from the image. The LPR system literally searches the image for things that look like characters.

The OCR technologies used in LPR systems closely parallel the systems used in modern document scanning and retrieval systems. The level of intelligence in this stage only represents the ability to recognize individual characters. This can be compared to a young child who knows his/her ABCs, but cannot read whole words.

Heuristics. High-level heuristics, or algorithms, combine the characters into actual license plate numbers. Following our analogy, this process takes the individual characters and “reads” them to find a license plate. This is where knowledge of license plates can be used to help eliminate a false read. For example, in a given state, the license plate always has three letters followed by a dash and four numbers. This can be used as a test to see if the data looks legitimate.



OUTPUT – The user output is the final link of the LPR chain. At the simplest level, it operates as a screen showing the license plate of the last vehicle to pass in

front of the LPR camera. A more sophisticated system will contain database tools and mapping and query capabilities. These advanced interfaces allow the user to inquire about license plates based on particular criteria such as license plates starting with the letter A, containing the numbers 3 and 7, and seen between 8 p.m. and 10 p.m. at a specific address. The type of user output needed is highly dependant on how the system will be used. It is important to properly identify the needs of the user when selecting an LPR system.

License Plate Recognition as a Tool

When looking at LPR systems, it must be noted that LPR is simply another tool in the modern law enforcement officer and security professional's arsenal. Physically watching a given area and recording license plates manually is a common approach to collecting license plate information. However, manually obtaining data could be cost prohibitive from a manpower perspective, whereas LPR is considered a force multiplier within law enforcement communities. LPR is also considered a safety tool for the law enforcement officer on patrol in a vehicle. License plates can be examined autonomously and the vehicle operator can be alerted only when a license plate of interest is found. LPR data can also be coupled with Global Positioning System (GPS) data. As the law enforcement officer performs a routine patrol, the location and license plate is recorded for every stationary or moving vehicle encountered by the officer's mobile LPR system. LPR is just one of many new tools that can be used in conjunction with the modern era of data fusion.

Example Applications

The fact that a license plate is universally required on all vehicles, provides a key point of identification for the operator of that vehicle. LPR systems automate the process of gathering this information. The following list of example applications is not meant to be exhaustive, but rather provide an overview of some areas where LPR technologies are deployed.

Access Control/Gate Control. Access control of restricted areas is often accomplished through a traffic control gate. LPR can control access by checking the car's license plate against a database of allowed vehicles. If a match is found, the gate is opened. This LPR system can be used



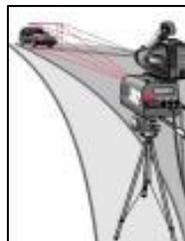
independently or in conjunction with other methods of access control.



Customs/Immigration. At border crossings and customs inspection areas, a large volume of vehicle traffic often occurs. LPR systems can be used to automatically scan the license plates of all vehicles approaching the border and search them against a database. The database could include stolen vehicles, related criminal histories, America's Missing Broadcast Emergency Response (AMBER) alerts, and other vehicles of interest. If something is found in the database, the vehicle can be routed to a different area for further investigation.



Mobile Vehicle Readers. By installing an LPR system in a patrol car, new opportunities are available to law enforcement officers. License plates can be identified at a distance while not distracting the driver. If the car is also equipped with GPS, the patrol car itself becomes a mobile tracking platform sending time, location, and license plate information to a distributed tracking system.



Speed Enforcement. By having multiple LPR systems at different locations, it is possible to measure the amount of time a particular vehicle transitions between two locations. Since the distance between the two LPR locations is static, the vehicle's average speed can be calculated. An automatic ticket can be generated and sent to the owner of the vehicle by cross-referencing the LPR information with an existing database.



Tracking and Traffic Management. In the case of a stolen vehicle or a car observed at the scene of a crime, LPR systems distributed in an area can be used to track subject vehicles. Each LPR has a known location and can provide the exact time a specific vehicle was observed. From this data, a tracking map can be created and the subject vehicle's location found. Similarly, LPR systems can also provide a mapping of traffic flow and be used as a car-counting mechanism aiding in the development of traffic management data.

